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SOME RECENT RESULTS IN RAILWAY STATISTICS IN THE UNITED STATES.

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STATISTICIAN INTERSTATE COMMERCE COMMISSION.

The year 1887 marks a new period in the development of railway statistics in the United States. Previous to this time all official statistics, except those of the Census Office, were collected and compiled under the authority of the Railway Commissioners of the various states. As might have been expected, the requirements of the several states were not harmonious, nor was it possible for any state to carry its line of statistics very far.

Under such circumstances the first effort of the Division of Statistics, created by the Interstate Commerce Commission in the fall of 1887, was to establish uniformity in the nature and scope of questions asked of railways, and it is one of the most promising features of railway statistics in this country that by far the larger number of state railway commissions have adopted the form for annual report of carriers, drawn up by the Interstate Commerce Commission. Many other steps have been taken toward the establishment of uniformity, the most fruitful being those which brought the Statistical Division in direct contact with the auditors of the various railways. The ideal condition for the collection of railway statistics would be one in which accounts of all railways are grounded on a uniform system of book-keeping. This ideal has been constantly held in mind, and the Statistical Division has always endeavored to work in harmony with the American Railway Accounting Officers' Association, an association having for its chief aim the attainment of uniformity in methods of accounting. The Executive Committee of this Association is at present engaged upon the final revision of the classification of operating expenses, the underlying principles

of which have been already adopted by the Railway Commissioners of the several states. Mention is made of these facts to show the direction in which the railway statistics are moving in the United States.

Confining my remarks to the Interstate Commerce Commission, the entire attention of the Statistical Division has not, however, been addressed to the development of a more perfect form of report and of accounts. A few steps have been taken in what primarily may be termed "scientific investigation." Although the character of the Commission and the limited funds at its disposal have prevented it from entering upon many investigations of great promise, the barrier to progress occasioned by the small amount of money assigned to the Statistical Division has been in part overcome by the fact that the Superintendent of the Eleventh Census considered it wise to place the Division of Transportation under the direction of the Statistician of the Interstate Commerce Commission. This has resulted in making the two offices, to a certain degree, supplemental to each other. I speak of this because the line of facts to which I purpose calling your attention are in part the work of the Census Office, and as they have not yet been formally published it is appropriate to make special mention of the source from which they come.

In 1890 the first attempt was made to classify railway statistics by territorial groups. The necessity of some classification of this sort will be readily recognized. In a country which extends from the Atlantic to the Pacific, and from the Great Lakes to the Gulf; which has all varieties of climate; which produces cotton, tobacco, rice, meats, wheat, corn, and all other cereals with equal facility; which contains all the minerals and nearly all the woods; which has developed manufacturing in all of its forms, and in which manufactures are highly localized; and, lastly, which is more perfectly supplied with railway facilities than any other country in the world (the great variety of its industries and extent of its

territory taken into account);—in such a country, I say, an average of any line of facts cannot be regarded as a type of anything in particular, because the facts from which the averages are deduced are too various, and contain too many anomalous units. To show that this is true I insert here a table taken from the Report of Railway Statistics for the year 1890, published by the Interstate Commerce Commission, giving for the various groups into which the territory of the United States is divided certain averages fundamental in railway statistics.¹ (See next page.)

It requires but a glance at this table to perceive how large a class of statistical problems present themselves for consideration. Each column in the table suggests a separate problem. Without speaking specifically of each set of facts, however, I desire to call your attention to the average revenue

¹ The territorial groups referred to in the table may be roughly described as follows :—

GROUP I. This group embraces the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

GROUP II. This group embraces the states of New York, Pennsylvania, New Jersey, Delaware, and Maryland, exclusive of that portion of New York and Pennsylvania lying west of a line drawn from Buffalo to Pittsburg *via* Salamanca, and inclusive of that portion of West Virginia lying north of a line drawn from Parkersburg east to the boundary of Maryland.

GROUP III. This group embraces the states of Ohio, Indiana, and the southern Peninsula of Michigan; also that portion of the states of New York and Pennsylvania lying west of a line drawn from Buffalo to Pittsburg *via* Salamanca.

GROUP IV. This group embraces the states of Virginia, North Carolina, South Carolina, and that portion of the state of West Virginia lying south of a line drawn east from Parkersburg to the boundary of Maryland.

GROUP V. This group embraces the states of Kentucky, Tennessee, Mississippi, Alabama, Georgia, Florida, and that portion of Louisiana east of the Mississippi River.

GROUP VI. This group embraces the states of Illinois, Wisconsin, Iowa, Minnesota, the Northern Peninsula of the state of Michigan, and that portion of the states of North Dakota and South Dakota and Missouri lying east of the Missouri River.

GROUP VII. This group embraces the states of Montana, Wyoming, Nebraska, that portion of North Dakota and South Dakota lying west of the Missouri River, and that portion of the state of Colorado lying north of a line drawn east and west through Denver.

GROUP VIII. This group embraces the states of Kansas, Arkansas, that portion of the state of Missouri lying south of the Missouri River, that portion of the state of Colorado lying south of a line drawn east and west through Denver and the territories of Oklahoma Indian Territory, and that portion of New Mexico lying northeast of Santa Fe.

GROUP IX. This group embraces the state of Louisiana, exclusive of the portion lying east of the Mississippi River, the state of Texas, exclusive of that portion lying west of Oklahoma, and the portion of New Mexico lying southeast of Santa Fe.

GROUP X. This group embraces the states of California, Nevada, Oregon, Idaho, Washington, and the territories of Utah, Arizona, and that portion of the territory of New Mexico lying southwest of Santa Fe.

SUMMARY OF SELECTED ITEMS, BY GROUPS.

Territory Covered.	Gross Earnings per Mile of Line.	Operating Expenses per Mile of Line.	Locomotives per 100 Miles of Line.	Men Employed per 100 Miles of Line.	Passenger Mileage per Mile of Line.	Freight Mileage per Mile of Line.
Group I.....	\$10,444	\$7,075	28	716	233,530	383,505
Group II.....	15,829	10,275	46	1,167	183,121	1,348,107
Group III.....	7,785	5,322	24	576	85,572	793,763
Group IV.....	4,279	2,886	13	379	43,039	330,981
Group V.....	4,945	3,278	14	386	46,869	304,936
Group VI.....	5,195	3,324	15	359	50,059	376,403
Group VII...	5,128	3,007	12	328	46,148	269,866
Group VIII..	4,056	2,613	12	307	37,027	243,753
Group IX.....	4,331	3,278	11	303	33,561	245,732
Group X.....	5,836	3,871	13	250	67,196	191,806
United States	6,725	4,425	19	479	75,751	487,245

Territory Covered.	Revenue per Passenger per Mile.	Revenue per Ton per Mile.	Per Cent of Passenger Earnings to Total Earnings.	Per Cent of Freight Earnings to Total Earnings.	Value of Railway Property per Mile of Line, Computed at 5 per Cent on Basis of Earning Capacity.
	<i>Cents.</i>	<i>Cents.</i>			
Group I.....	1.912	1.373	47.50	51.36	\$57,867
Group II.....	2.029	.828	27.33	70.28	107,741
Group III.....	2.199	.695	28.72	69.33	45,941
Group IV.....	2.481	.844	30.94	66.93	25,177
Group V.....	2.465	1.061	29.16	67.77	30,206
Group VI.....	2.226	.961	26.87	70.97	36,406
Group VII.....	2.452	1.360	27.46	71.19	38,136
Group VIII.....	2.268	1.152	25.96	69.99	27,168
Group IX.....	2.583	1.303	23.88	74.42	14,593
Group X.....	2.308	1.651	34.85	61.74	22,672
United States.....	2.167	.941	29.41	68.23	42,374

per ton per mile in the several territorial groups, which varies, it will be observed, from .695 cents in Group III to 1.651 cents in Group X. Are there any figures at command which serve to explain in any degree this variation?' It is this question to which I now invite your attention.

The factors generally accepted as determining railway charges are: physical characteristics of railways, the commercial condition under which transportation is carried on, and

the competitive condition to which railways are exposed. To measure the relative influence of these elements presents a practical problem of the utmost importance, and at the same time a scientific problem which commands the interest of statisticians. It is, indeed, the peculiar function of statistics to solve such a problem.

The importance of physical characteristics, the most significant of which are gradients, curves, and distance from coal supply, has been greatly overestimated, and it has been one of the results of recent railway statistics in this country to show that engineers have committed the error of laying too great stress upon curves and grade. I need not dwell upon this fact, for a glance at the average receipts per ton per mile for the ten territorial divisions, and a mental review of the relative difficulty in railway construction in them, will convince one that physical characteristics of lines cannot exert a great influence upon railway rates. We may then pass this factor without further consideration.

Under the head of commercial conditions, under which transportation is carried on, there are included quite a number of distinct and varying factors. Speaking generally, these are density and character of population served by railways, and the amount, density, and character of freight hauled. All these factors are capable of comparative measurement. Omitting, for the moment, the kind of freight peculiar to the various groups, the facts which throw light upon their commercial character are presented in the following table, which shows for each group the number of miles of railway, the population, the number of miles of line per 10,000 inhabitants, the number of miles of line per 100 square miles of territory, the amount of traffic measured in tons, the amount of traffic per inhabitant measured in ton miles, the density of traffic, the density of load, the average haul per ton as reported by the roads, and the percentage of freight received from connecting lines, and consequently calling for no loading expenses. There is also added to the table the rate per ton

per mile for each group, being the figures that are to be explained.

SUMMARY SHOWING COMMERCIAL CONDITION UNDER WHICH RAILWAYS WERE OPERATED, BY GROUPS, FOR YEAR ENDING JUNE 30, 1890.

Territory Covered.	Ton Miles per Inhabitant.	Ton Miles per Mile of Line.	Number of Tons in Train.	Average Haul per Ton.	Per Cent Freight Received from Connecting Lines.	Revenue per Ton per Mile.
						<i>Cents.</i>
Group I.....	606	383,505	122.29	69.04	51.00	1.373
Group II.....	1,688	1,348,107	218.26	96.59	52.00	.828
Group III.....	1,977	793,763	217.58	120.94	57.00	.695
Group IV.....	579	330,981	161.92	170.20	37.00	.844
Group V.....	534	304,936	138.49	107.11	38.00	1.061
Group VI.....	1,401	376,403	148.29	155.40	24.00	.961
Group VII.....	1,658	269,866	150.28	167.83	47.00	1.360
Group VIII.....	1,049	243,753	148.49	172.01	45.00	1.152
Group IX.....	659	245,732	123.70	224.08	36.00	1.303
Group X.....	831	191,806	123.04	193.55	27.00	1.651
Total, United States	1,213	487,245	175.12	119.72	48.00	.941

Territory Covered.	Miles of Line.	Population.	Number of Miles of Line per 10,000 Inhabitants.	Number of Miles of Line per 100 Square Miles of Territory.	Number of Millions of Tons Carried.
Group I.....	6,877.67	4,700,745	12.06	11.09	41.25
Group II.....	18,613.82	13,767,388	13.52	17.18	240.58
Group III.....	21,718.27	8,394,816	25.88	17.25	137.20
Group IV.....	9,032.08	4,945,827	18.28	6.49	16.84
Group V.....	18,635.09	9,059,032	20.59	6.22	45.20
Group VI.....	37,463.44	10,263,750	36.52	10.07	92.51
Group VII.....	8,886.93	1,433,888	62.02	2.15	14.16
Group VIII.....	20,355.20	4,919,929	41.45	5.57	30.00
Group IX.....	9,854.18	2,976,630	33.16	3.04	8.76
Group X.....	12,160.37	2,339,566	52.18	1.60	10.04
Total, United States....	163,597.05	62,801,576	26.05	5.51	636.54

A word of explanation may be necessary for the correct interpretation of the figures in the columns headed: The Average Haul per Ton, and Percentage of Freight Calling for no Loading Expenses. The average haul per ton for each

group is determined by dividing the aggregate of ton-mileage in each group by the total number of tons reported as carried. For each group taken by itself the averages of the table are correct if the figures are properly interpreted. For the United States as a whole, however, the true average haul per ton is 220 instead of 119 miles. The figure 119 is obtained by dividing the total ton-mileage by 636 millions of tons of freight, which is the aggregate of freight carried, as reported by all the lines. A classification of this freight has been made in the Census Office from which it appears that only 330 millions is taken up by the roads at their stations, the remainder being received from connecting roads. This shows that the true basis of railway operations is much nearer 330 millions of tons than 636 millions of tons, and that this figure should be accepted as the divisor in determining the average length of haul for each ton in the United States. The significant fact, so far as the cost of transportation is concerned, is that tonnage received from connecting roads is usually the occasion of no loading expenses, and, in the last column of the above table, I have made an estimate of the proportion of freight calling for no loading expenses in each of the several groups, using as the basis of this estimate the amount of freight reported in each group as originating on the line of the company making report, and the amount reported as received from connecting lines. With this explanation the figures in the above table may, I believe, be easily understood.

An expert might, perhaps, be able to read from a large number of averages in the above table the statistical law which they contained. In order, however, to render this task more easy I have subjected the most important data to a different arrangement. Thus, the table next inserted shows the order in which the several groups stand when arranged according to a plan of progression. For the purpose of explanation it will be observed that in the column headed "Revenue per Ton per Mile," the groups are arranged in order,

beginning with the group which shows the smallest and ending with the group which shows the largest revenue per ton per mile. In the other columns the order of progression is inverse to the density or quantity or significance of the factor considered.

The first fact which a consideration of the above table impresses is the remarkable coincidence between density of traffic and the number of railways per 100 square miles of territory, as shown by the order in which the groups arrange themselves in the second and third columns. Upon the basis of this exhibit one may with confidence assume that density of traffic and railway facilities are interchangeable terms.

Further observation discloses a certain degree of uniformity in the recurrence of the remaining items, and in their assignment to the revenue per ton per mile. To indicate this I have connected by lines several of the groups in the various columns of the table. Thus it will be observed that Groups II, III, V, IX, and X exhibit a fair degree of uniformity in the order in which they appear in the several columns of the table, so much so, indeed, that we are authorized to lay down, at least hypothetically, the law that railway charges vary according to the commercial conditions implied by the density of traffic, density of load, and exemption from loading expenses.

Of the groups which vary from this rule it will be observed that Groups IV and VI vary on account of the item, exemptions from loading expenses. In Group VI, for example, which in density of traffic and density of load stands third in order, one would be justified, I think, in saying that it would also stand third in revenue charges were it not for the high average of loading expenses which the railways of this group sustain. Group I, that is to say, the New England states, exhibits the greatest fluctuation, but the railways in this group in every particular stand apart from the railways of the other parts of the country. They are the only railways of the entire country which depend largely upon passenger as

compared with freight traffic, and they are also exempt, in large measure, from the competition to which other roads are exposed.

Group VIII shows a lower rate per ton per mile than might have been expected, while Group VII may be accepted as conforming fairly well to the general rule, if it be noticed that because roads of this group do not show either density of freight or density of load, the high relative charge for loading can bear but slight relative importance.

There is another very important commercial condition not represented in the above tables which must be noticed. I refer to the character of the freight carried by the railways of the various groups. In the following table, presented by courtesy of the Census Office, the total freight carried by the railways of the United States during the year 1890 is classified as products of agriculture, products of animals, products of mines, products of forest, manufactures, merchandise, and miscellaneous.

SUMMARY EXHIBITING THE FREIGHT TRAFFIC BY COMMODITIES OF THE
RAILROADS OF THE UNITED STATES IN THE YEAR ENDING
JUNE 30, 1890. ALL GROUPS.

Commodities.	Totals for United States.				
	Freight Originat- ing on all Roads.	Freight Received from Con- necting Lines and Other Carriers.	Unsegre- gated Tonnage.	Total Freight Tonnage.	Per Cent.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	
Totals.....	274,112,866	258,981,868	107,357,814	640,452,548	100.00
Products of agriculture.....	28,865,536	41,041,868	16,629,253	86,536,657	13.51
“ “ animals.....	10,497,285	11,680,799	4,249,944	26,428,028	4.13
“ “ mines.....	129,977,648	115,244,678	26,323,374	271,545,700	42.40
“ “ forest.....	32,674,105	21,714,792	9,400,288	63,798,185	9.96
Manufactures.....	37,093,806	34,929,964	7,927,000	79,950,770	12.48
Merchandise.....	12,946,615	10,900,392	5,899,806	29,746,813	4.65
Miscellaneous (commodities mentioned above).....	22,057,871	23,469,375	36,919,149	82,446,395	12.87

The Census Office made a computation similar to the one presented in the above table for the United States for each of the territorial groups. In place, however, of producing these figures entire there will be found in the table on next page a statement of the aggregate number of tons carried in each group, and the percentage of each class of freight to this aggregate. There is also inserted a map of the United States which makes a graphic exhibit of these data.

Unless one's attention has been called to an analysis of railway freight, he will, I venture to say, be somewhat surprised at the above presentation. The average rate per ton per mile on all the railways of the United States is .860 cents. We have already discovered one reason for this apparently low rate in the fact that the average haul per ton is 220 miles, and now another reason for this low rate appears in the fact that by far the greater per cent of freight is low grade freight. Thus, agriculture, animal products, mines, and forests account together for nearly 75 per cent of total freight carried. Mines supply the railways with nearly 50 per cent of their total traffic.

The problem which we have set before us, however, pertains to the relative rates in the various groups, rather than the actual rate in the United States as a whole, and, without making a particular analysis of the freight carried in each group, a casual glance will show that this is a very important element in the making of rates. In Group II over 60 per cent of the total freight is the product of mines, and in Group III over 40 per cent, but in Group III forestry, agriculture, and animal products, low class freight, show a higher percentage than in Group II. This, taken in connection with the fact that Group III is most favorably situated of any group in the country as regards expense of loading, and, also, with the fact that railways within this group running north and south are heavily loaded with mineral products in both directions, fully explains why the average receipts per ton per mile are lower than in any other group. It is possi-

TABLE SHOWING RELATIVE AMOUNT OF FREIGHT, OF CLASSES NAMED, MOVED BY RAILWAYS IN THE SEVERAL TERRITORIES;
 RAIL GROUPS; ALSO AGGREGATE NUMBER OF TONS MOVED.

Class of Commodities.	Group I.	Group II.	Group III.	Group IV.	Group V.	Group VI.	Group VII.	Group VIII.	Group IX.	Group X.	The United States.
Agricultural products.....	10.14	8.40	13.62	14.07	15.88	20.55	18.96	23.76	20.39	21.24	13.51
Animal products.....	4.15	2.50	4.46	2.70	2.49	5.57	7.01	9.55	11.30	5.00	4.13
Mineral products.....	14.63	60.35	42.66	35.15	22.79	31.02	21.40	32.62	16.23	19.83	42.40
Forest products.....	6.65	6.65	12.13	16.10	12.16	10.87	9.15	12.82	25.09	18.49	9.96
Manufactures.....	7.60	13.67	17.68	15.69	11.92	7.60	5.14	4.57	9.83	11.52	12.48
Merchandise.....	7.38	2.89	4.69	6.56	5.62	5.12	3.83	8.11	9.46	15.20	4.65
Not classified.....	50.05	5.54	5.36	9.73	29.14	19.27	34.51	8.57	7.70	8.42	12.87
Aggregate number of tons carried.....	39,475,504	227,293,176	139,372,456	19,215,102	44,382,018	94,086,235	13,625,381	31,587,663	11,398,302	10,066,711	640,452,548

ble, also, that the competition which the railways of this group sustain with lake traffic has something to do with its low rate, although my personal opinion is that lake traffic is a less important element in forcing down railway rates than is commonly supposed. The truth is that steam vessels have forced sailing vessels to the wall, and the railways have captured the steam vessels.

I shall not extend this paper for the special analysis of the traffic of each group, but I cannot refrain from calling your attention to group IV. It is somewhat surprising that the receipts in this group are lower than in all other groups, with the exceptions of Group II and Group III. There is nothing in the commercial conditions to justify such low rates, and it is quite likely that this group is influenced more largely by water competition than any other in the United States.

This paper must be regarded as a contribution to the solution of the problem of railway rates. It certainly is not conclusive respecting them. It is believed, however, that it follows the logical order of treatment in that it endeavors to give a comparative measurement of the commercial conditions under which railway traffic is carried on, assuming that what in this manner, cannot be explained must be referred to the financial condition of the various railways, and to the competitive conditions under which they are operated. The facts which it contains are the latest contributions to railway statistics in the United States.

I cannot close, however, without the suggestion that a schedule of rates which holds in mind the commercial and industrial interests of the public must adjust itself to the character of the industries whose products the railways carry. An investigation into the localization of industries, and the amount of various kinds of traffic originating in the several sections of the country, should be the basis upon which railway rates are adjusted.